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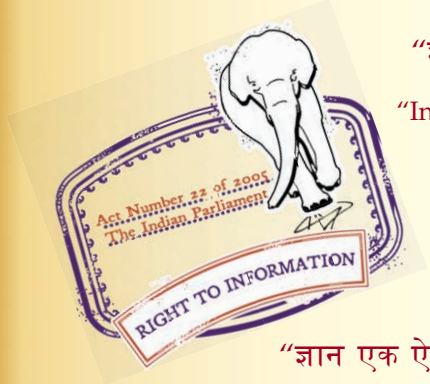
IS 10485 (1983): Code of practice for the installation of single and community antenna systems for the reception of sound and television broadcasting [LITD 12: Transmitting Equipment for Radio Communication]

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Bhartṛhari—Nītiśatakam
"Knowledge is such a treasure which cannot be stolen"

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IS : 10485 - 1983
Reaffirmed 1989
( Reaffirmed 2003 )

*Indian Standard*

# CODE OF PRACTICE FOR INSTALLATION OF SINGLE AND COMMUNITY ANTENNA SYSTEMS FOR RECEPTION OF SOUND AND TELEVISION BROADCASTING

UDC 621·396·67·005 ( 026 ) : 621·397·13



**INDIAN STANDARDS INSTITUTION**
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 8

*July* 1983

# *Indian Standard*

# CODE OF PRACTICE FOR INSTALLATION OF SINGLE AND COMMUNITY ANTENNA SYSTEMS FOR RECEPTION OF SOUND AND TELEVISION BROADCASTING

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# *Indian Standard*

# CODE OF PRACTICE FOR INSTALLATION OF SINGLE AND COMMUNITY ANTENNA SYSTEMS FOR RECEPTION OF SOUND AND TELEVISION BROADCASTING

## 0. FOREWORD

**0.1** This Indian Standard was adopted by the Indian Standards Institution on 18 February 1983, after the draft finalized by the Radio Communications Sectional Committee had been approved by the Electronics and Telecommunication Division Council.

**0.2** This code of practice is intended for the guidance of manufacturers and customers of single and community antenna systems for the reception of sound and television broadcasting.

**0.3** This code of practice is based on British Standard CP 1020-1973 'The reception of sound and television broadcasting', issued by British Standards Institution.

## 1. SCOPE

**1.1** This code of practice recommends erection and cabling of single and community antenna systems (that is, antennae and associated equipment) for good reception of sound and television broadcasts. It includes the protection of such systems against atmospheric electricity and recommendations for the certification of the systems.

NOTE 1 — Compliance with the recommendations given in this code does not confer immunity from relevant legal requirements, if any.

NOTE 2 — The single or community antenna system is supposed to feed to the proper receiving apparatus covered by relevant Indian Standards such as IS : 615-1966*, IS : 4547-1978† and IS : 6759-1972‡.

*Minimum requirements of domestic radio receivers ( *revised* ).

†Specification for receivers for monochrome television broadcast transmissions ( *first revision* ).

‡Requirements for radio receivers for frequency modulation broadcast transmissions.

## 2. TERMINOLOGY

**2.1** For the purpose of this standard the following terms and definitions in addition to those already specified in IS : 1885 ( Parts XVIII to XXII)-1967* shall apply.

**2.2 Antenna** — A single element or an assembly of elements so spaced and connected as to have the necessary receiving properties.

**2.3 Antenna Cable** — A cable connecting an antenna to its associated terminal equipment.

**2.4 Antenna Mast** — The supporting structure for an antenna, including any brackets, struts and stays.

**2.5 Antenna System** — A system comprising one or more antennae on a single mast, the appropriate single-cable distribution system, and other appropriate components, which will enable the intended reception of sound or television broadcasts.

**2.6 Bonding** — The connection of a circuit or a component ( that is required to be bonded ) to the metallic cold water mains or electricity supply earth point ( where permitted ), by means of a conductor or conductors in such a manner that a resistance of 0·2 ohm is not exceeded and a current of 30 A may be carried for a period of 5 s.

**2.7 Channel Converter** — A device for changing the carrier frequencies of all the signals in a particular channel before the signals are transmitted on a cable distribution system.

**2.8 Community Antenna System** — A common antenna system serving a group of independent users ( for example, households, business concerns, etc. ) and in which signals received by the antenna system are distributed, by a cable distribution system, to a number of television or sound receivers or both.

**2.9 Cross Modulation** — The modulation, arising from the interaction of the radio frequency signals in nonlinear circuits, of a wanted signal by the modulation of an unwanted signal on a different carrier frequency.

**2.10 Head End** — Any equipment that is connected between one or more antennae or other signal sources and the distribution network in order to process the signals that are to be distributed.

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*Electrotechnical vocabulary :
Part XVIII General terms on radio communications.
Part XIX Radio communication circuits.
Part XX Radiowave propagation.
Part XXI Aerials.
Part XXII Equipments for radio communications, transmitting and receiving.

**2.11 Mutual Attenuation** — The attenuation at specified frequencies, between any two outlet sockets within a distribution system.

**2.12 Outlet Socket** — A socket provided for the connection of a standard receiver ( sound or television or both ) to the antenna system.

## 3. EXCHANGE OF INFORMATION

**3.1 Installation Requirements** — The initial and ultimate requirements should be ascertained by the contract or from the client. On the basis of this information a specification, drawings and schedule of requirements should be prepared and should include as appropriate:

a) broadcast services to be received;

b) number, location and finish of distribution points;

c) location of central equipment;

d) location of aerials;

e) signal levels at the outlets;

f) anticipation of future requiremets; and

g) operating and safety instructions.

NOTE — The above practice is essential for cable distribution system and desimable for systems with single outlet to a receiver. In case of contracts for buildings under construction the architect and the consultant as appropriate should also be made parties to the contract.

## 4. TIME SCHEDULE

**4.1 Initial Planning** — Time should be allowed for:

a) preparation of installation requirements, and when appropriate

b) submission of tenders,

c) appraisal of tenders, and

d) approval of proposals before contract is let.

**4.2 Ordering Central Equipment** — For large installations the equipment may have to be specially manufactured and should be ordered early to ensure its availability at the right time for installation.

**4.3 Installation of Equipment** — Work may commence on the installation of the equipment at any stage of the building work provided that all building work in the actual room, including decoration, is finished, and that the room is dry. Electric light and power should be available at the commencement of the installation. Work of other contractors likely to give rise to dust should not be carried out in the vicinity after installation of the central equipment has begun.

**4.4 Antennae** — Antennae fittings may be installed at any convenient stage of the building work.

**4.5 Wiring** — Wiring in ducts, conduits, chases and the like should be carried out at a late stage of building construction.

## 5. MATERIALS, APPLIANCES AND COMPONENTS

**5.1 Cables and Wires** —Standard types of cables and wires known to give a reliable performance should be used.

**5.2 Socket Outlets and Plugs** — Socket outlets and plugs used for telecommunication services should not be interchangeable with those used for electric light or power circuits.

**5.3 Quality of Materials** — The quality of materials, finish and the performance of the components, apparatus and equipment should be adequate to meet the test requirements specified in **8** and to ensure satisfactory operation for the designated period.

**5.4 Fire and Explosion Risk** — The provision of telecommunication equipment in any situation where there may be an explosive or flammable atmosphere should be avoided. Where no alternative exists and it becomes essential to install telecommunication equipment then the equipment certified to be intrinsically safe and flameproof should be used.

## 6. PLANNING AND DESIGN CONSIDERATIONS

**6.1 Antenna and Earth System** — It is customary for long and medium wave receivers for domestic use to be fitted with internal antenna and in majority of cases these provide reception of a quality that the listener considers to be satisfactory. Receivers for short wave and for very high frequency ( VHF ) are commonly provided with a telescopic antenna intended to be stretched when the receiver is in use. Where reception with such an inbuilt antenna is not satisfactory and the design of the receiver permits, reception is usually improved by using an antenna external to the receiver and preferably outside the building. Where an external aerial is used, an earth connection should also be used.

Where because of screening, interference or planning restrictions it is either undesirable or impractical to use individual antennae, it is strongly recommended that a community antenna and wired distribution system be used ( **6.4** ). This may be combined with a system for the distribution of television signals when appropriate.

### 6.2 Sound Reception

**6.2.1** *Services to be Received* — Sound broadcasting in the following frequency sounds is dealt with in **6.2.2** and **6.2.3.** Receivers may receive

transmissions in any one of these bands, combination of these bands or all these bands:

| | |
|---|---|
| Medium-wave band | 525·5 — 1 606·5 kHz |
| Short-wave band | 2·3 — 26·1 MHz |
| VHF band | 87 — 109 MHz |

**6.2.2** *Antenna Systems for the Medium-and Short-wave Bands*

**6.2.2.1** *Outdoor antenna systems* — Basically both vertical and horizontal antennae are capable of giving satisfactory results, and practical conditions at the receiving site may indicate the type to be used in individual cases. For reception in weak signal areas a high horizontal antenna is to be preferred.

Antenna should preferably be mounted above roof level. Care should be taken to keep the antenna and the lead-in as far as possible, away from any source of interference and from metallic objects that may conduct and radiate interference. Care may be taken of the pipes and electrical wiring often concealed in the walls of modern buildings.

**6.2.2.2** *Vertical antenna* — A vertical antenna usually takes the form of a metal rod, properly insulated from its support. The insulated wire connecting the antenna to the receiver should also be vertical as far as possible and a permanent and weather-resistant electrical connection should be made between the antenna and the wire.

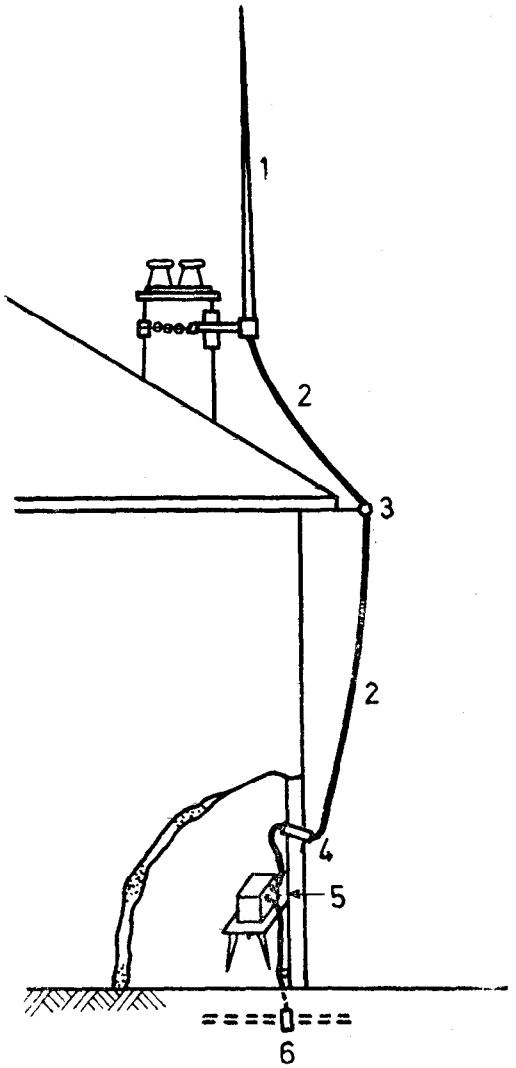
For private houses it is usually satisfactory for the antenna to be fitted as illustrated in Fig. 1.

Where this arrangement is impracticable, the antenna may be fixed in various positions, for example to a point on a window sill with some loss of effectiveness.

**6.2.2.3** *Horizontal antennae* — The most usual arrangement consists of a horizontal wire with a lead-in from the near and direct to the receiver, the whole forming roughly an inverted letter 'L' as in Fig. 2.

The support for the house end of the antenna should be taken to a high point and a support at the far end should be approximately of the same height. The lead-in should be taken from a point situated at some distance from the house so that it hangs clear of the wall and away from pipes and gutters. As far as possible the wire should not run parallel to other nearby conductors.

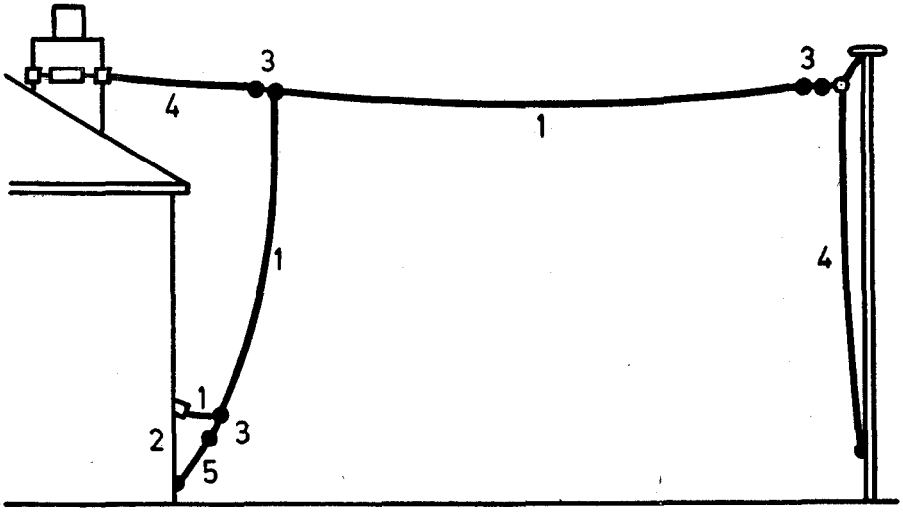
Insulated copper wire should be used, suspended by low capacitance insulators at each end. The horizontal wire and lead-in should preferably be a continuous length of wire.




1 Metal rod aerial mounted on insulating support.
2 Down-lead.
3 Insulator supportiag down-lead clear of gutter.
4 Lead-in tube through wall.
5 Earth terminal.
6 Earthing lead ( *see* **6.7** ).

NOTE — Precautions against the effects of atmospheric electricity are dealt with in **6.6**.

FIG 1. EXAMPLE OF OUTDOOR AERIAL AND EARTH SYSTEM




1 Aerial wire and lead-in in one continuous insulated length.
2 Lead-in tube through wall or window frame.
3 Insulators.
4 Wire suspensions.
5 Steadying stay for down-lead.

NOTE — Precautions against the effects of atmospheric electricity and dealt with in **6.6**.

FIG. 2 EXAMPLE OF AN 'INVERTED L' AERIAL

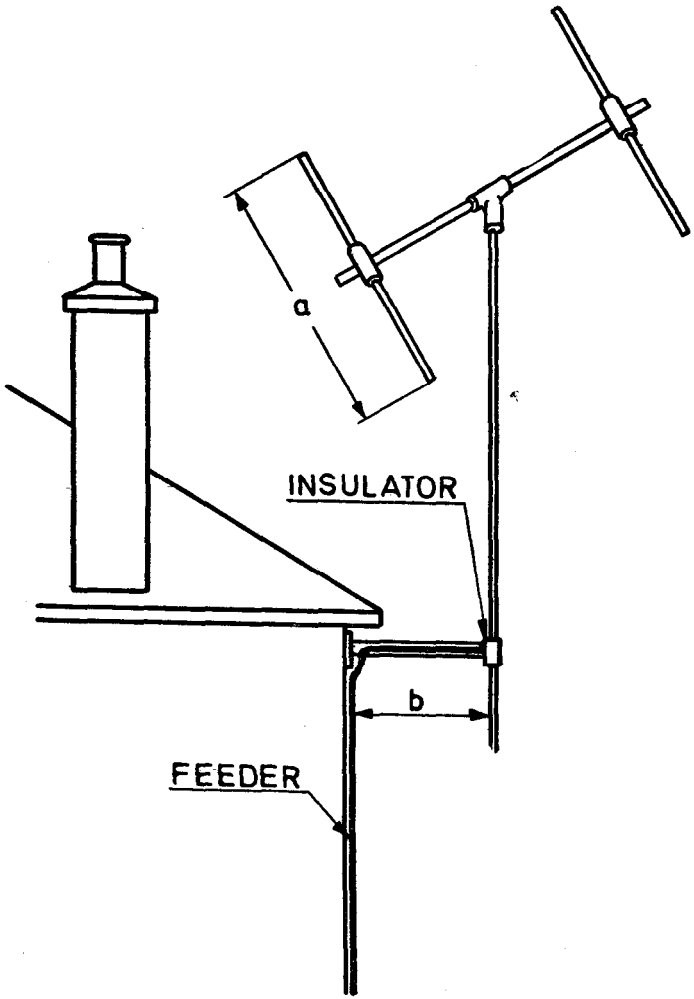
**6.2.3** *Antenna System for VHF Band* ( 87-109 MHz)

**6.2.3.1** *General* — Antennae for the reception of very high frequency sound broadcasting take the same general form as television antenna systems in that they consist basically of elements that resonate at frequencies to be received. As with television the type of antenna needed depends upon local reception conditions and it should not be assumed that an effective outdoor antenna is unnecessary because the listener lives within a few kilometres of the transmitting station.

The placement and positioning of the antenna is most important and has to take into consideration : ( a ) the polarisation of the transmitters and ( b ) the fact that there may by large differences in signal strength at points only about one metre apart, particularly in built up areas, and this effect may not be the same at all frequencies on which a station transmits.

VHF antennae with appropriate directivity, depending upon the conditions of reception, should be used. Using high directivity antennae in areas of low field strength or where interference is experienced is recommended. A few conventional types are shown in Fig. 3, 4, 5, 6

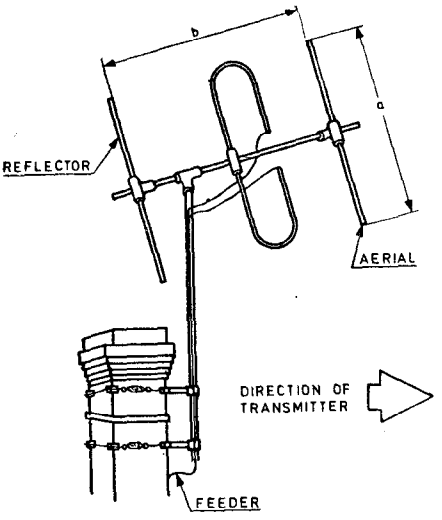
and 7. A characteristic form of distortion ( buzzing sound ) may be heard in areas where signals reflected from hills or large structures are received in addition to the main signal. Highly directional antenna carefully placed should be used under the situation.




The overall dimension *a* is approximately one-half of the wavelength of the service concerned; for Band I *a* will be between 2·3 m and 3·4 m depending upon the channel to be received, and for Band II it will be 1·5 m. The dimension *b* should be at least 0·76 m for Band I and may be proportionately less for Band II.

NOTE — Precautions against the effects of atmospheric electricity are dealt with in **6.6**.

FIG. 3 EXAMPLE OF SIMPLE HALF-WAVE DIPOLE




The dimension *a* is the same as for a simple dipole ( *see* Fig. 3 ) and the reflector is slightly longer. The dimension *b* is between one-quarter to one-eight wavelength depending on the design of the aerial.

NOTE — Precautions against the effects of atmospheric electricity are dealt with in **6.6.**

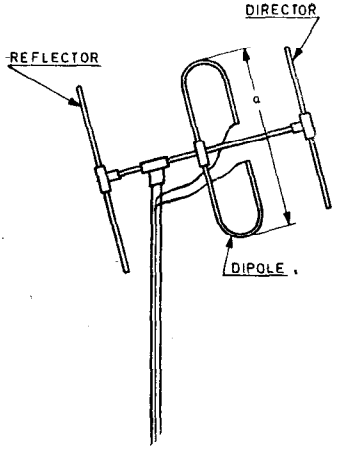
FIG. 4 EXAMPLE OF HALF-WAVE DIPOLE AERIAL WITH REFLECTOR

**6.2.3.2** *Indoor antenna* — When a VHF receiver is used with an antenna fitted inside the cabinet or with a telescopic rod antenna it will be usually necessary to try alternate positions in the room and as the inbuilt antenna is directional the receiver may need to be facing in a certain direction. When antennae of these types are found to be inadequate, a simple antenna erected preferably in the roof space may be satisfactory.

The use of any form of antenna inside ferro-concrete or steel framed buildings is likely to give unsatisfactory reception and is not recommended.

## 6.3 TELEVISION RECEPTION

**6.3.1** The television programmes transmitted in India are so far in Band I ( VHF ) channels 2-4 ( 47-68 MHz ) and Band III ( VHF ) channels 5-12 ( 174-223 MHz ). Television antennae may be required to receive one or more channels in one or both bands. Antennae will be required to receive channels also in the 'Ultra High Frequency' band as and when the transmission in this band is adopted.



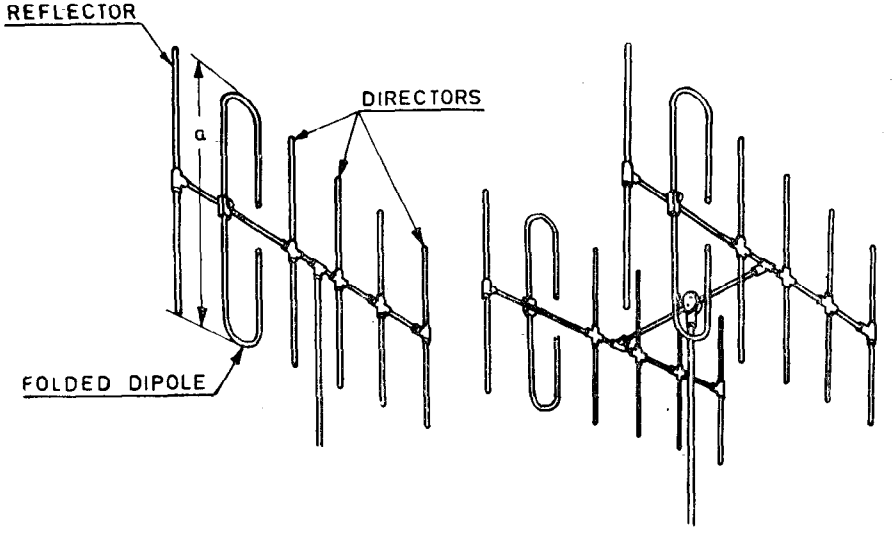

The dimension *a* is approximately one-half the wavelength concerned, as follows:

Band I — between 2·3 m and 3·4 m depending on the channel used;
Band II — 1·5 m; and
Band III — 0·69 m to 0·84 m.

The spacing between the elements depends upon the design of the aerial and the dipole is sometimes of the folded type, as indicated in Fig. 6.

NOTE — Precautions against the effects of atmospheric electricity are dealt with in **6.6.**

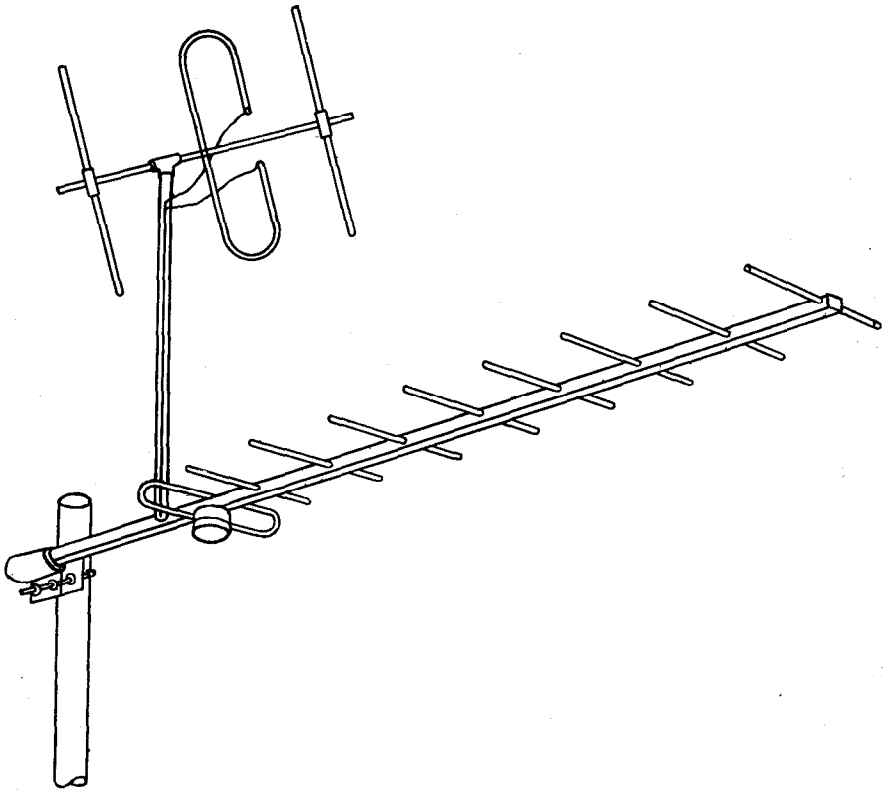
FIG. 5 EXAMPLE OF THREE-ELEMENT AERIAL




Dimension *a* is approximately one-half the wavelength concerned. For Band III the dimension is 0·69 m to 0·84 m. The spacing between the elements depends upon the design of the aerial.

NOTE — Precautions against the effects of atmospheric electricity are dealt with in **6.6.**

FIG. 6 EXAMPLE OF HIGHLY-DIRECTIONAL AERIALS



NOTE — Precautions against the effects of atmospheric electricity are dealt with in **6.6.**

FIG. 7 EXAMPLE OF AERIALS USED FOR VHF RECEPTION

**6.3.2** *Basic Requirements for Good Reception* — The strength of the signal received decreases rapidly with increasing distance from the transmitting station. The use of an effective antenna is of utmost importance. Apart from providing the receiver with adequate input voltage, the antenna has other functions like minimizing multiple images, discriminating against unwanted signals, etc.

In situations where it is undesirable to use individuals antennae (for example, in blocks of flats) a community antenna system should be provided or connection made to the existing wired distribution system (**6.4**). Where feasible, this could also be combined with a system for the distribution of sound signals (*see also* **6.1**).

**6.3.3** *Antenna System for Television Reception*

**6.3.3.1** *General* — The conventional type of antennae used for television reception are shown in Fig. 3 to 7. The antenna could be mounted vertically or horizontally depending upon the polarization of the transmitting station. The directional properties of the antenna are used to take advantage of directive gain, minimizing multiple images, and rejecting unwanted signals.

The three most important electrical parameters to be considered are forward gain, directional properties and band width. The directive properties of the antenna to be considered are of greatest importance in areas where the signal is weak or where reflected signals or interference from other stations using the same channel may occur.

**6.3.3.2** *Antenna for band I* — The design of the antenna or the antenna system shall be such that it is suitable for use with standard television receivers that comply with the relevant recommendations of IS : 4547-1978* at the location at which it is intended to operate.

Usually antennae for band I are designed for a particular channel and may take a suitable form as in Fig. 3 to 7. The actual size of the antenna will be guided by the prevailing field strength and the problems of interference or multiple images at the site under consideration.

**6.3.3.3** *Antenna for band III* — The characteristics of radio propogation and reception in band III require higher sensitivity for the antenna system thant hat required for band I system. The problem of multiple images is also more troublesome. Use of antennae with multiple elements as in Fig. 5 and 6 is recommended. Band III antennae may be so designed as to cover more than one channel for the whole of band III. This is particularly convenient when an area is served by two or more transmissions originating from approximately the same direction.

The system of the performance shall be such that when a television receiver that complies with the requirements of IS : 4547-1978* is connected to the outlet socket and tuned to the respective transmission the reproduction of both sound and vision is acceptable.

**6.3.3.4** *Composite band I and band III antenna* — Antenna can be designed to receive one or possibly two channels in band I as well as one or more channels in band III. The performance of this antenna shall be acceptable on all channels it is intended to receive. If the band I and band III transmitters do not lie in the same direction it will be necessary

*Specification for receivers for monochrome television broadcast transmissions (*first revision*).

to select a type in which the antenna for the two bands and channels can be separately oriented. In fringe areas or where local conditions make reception difficult use of separate antennae for band I and band III is recommended.

**6.3.3.5** *Indoor antenna* — The use of any form of antenna inside feroconcrete or steel framed buildings is likely to give inadequate reception and is not recommended.

It is some times possible to obtain satisfactory reception with an antenna installed in the loft or roof space. Greater care is required in siting such antennae. The use of room antenna is generally deprecated because these tend to give variable reception and inferior pictures.

## 6.4. COMMUNITY ANTENNA AND WIRED DISTRIBUTION SYSTEM ( *see* Fig. 8 and 9 )

**6.4.1** *General* — Distribution systems provide a means of distributing sound or television programmes, or both, over a wire network to a number of receivers that may be within individual dwellings, in dwelling in a block of flats or in rooms in a hotel, etc. The programmes may be derived from a wired input to the building or from an antenna system or from both. The wired system will comprise of any necessary equipment to process or amplify the incoming programmes.

**6.4.2** *Antennae* — The requirements for the antennae are the same as those for feeding individual receivers, although it is normally possible and desirable to use a better and more advantageously sited antenna system.

**6.4.3** *Distribution of Television and Sound Programmes* — A typical system will include most, but not necessarily all of the following components ( *see* Fig. 10 ).

a) the antenna system for which it will generally be necessary to the best position for a given dwelling pattern or a building;

b) in weak field strength areas, low-noise preamplifier(s) located close to the antenna system elements;

c) amplifiers and channel translators, converters, and combining units;

d) trunk, branch and spur feeders;

e) equalizers ( normally incorporated in amplifiers );

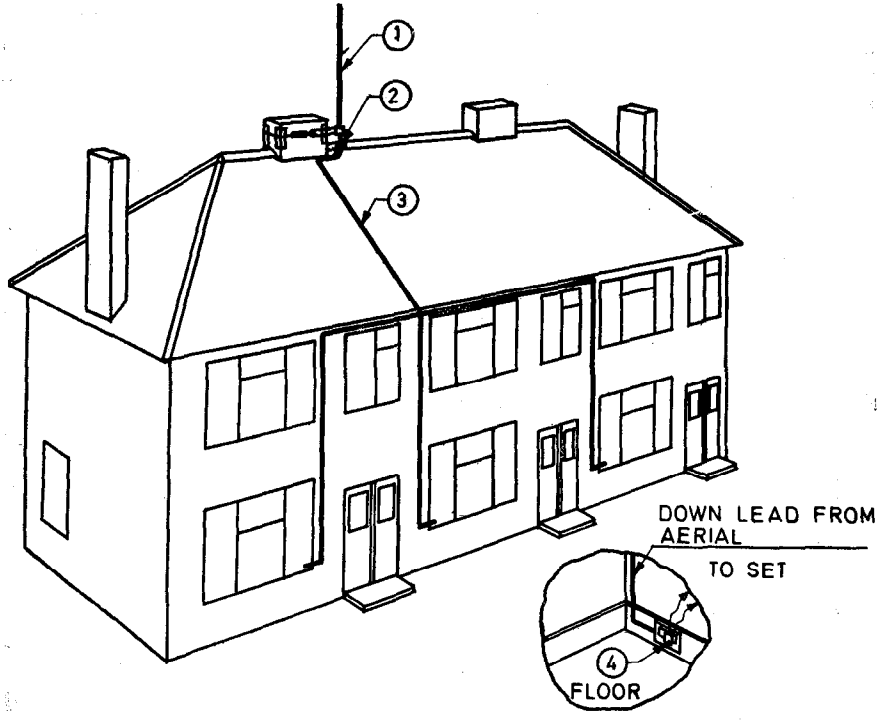
f) subscriber feeders and tap-off units; and

g) subscriber outlet units.

It is generally impractical to feed a number of receivers from one antenna system without additional amplification. It may become

necessary, to translate the signals or signals to a channel that is otherwise unused in the area in order to avoid interference problems that can arise.

Splitting or distribution units are used to divide the signal between different cable routes and should be designed to ensure a correct match to the cable. Subscribers are connected to the spur feeder. The tap-off units also limit signals being fed back from receiver into the spur feeder.




1 Metal-rod aerial mounted on insulated support.

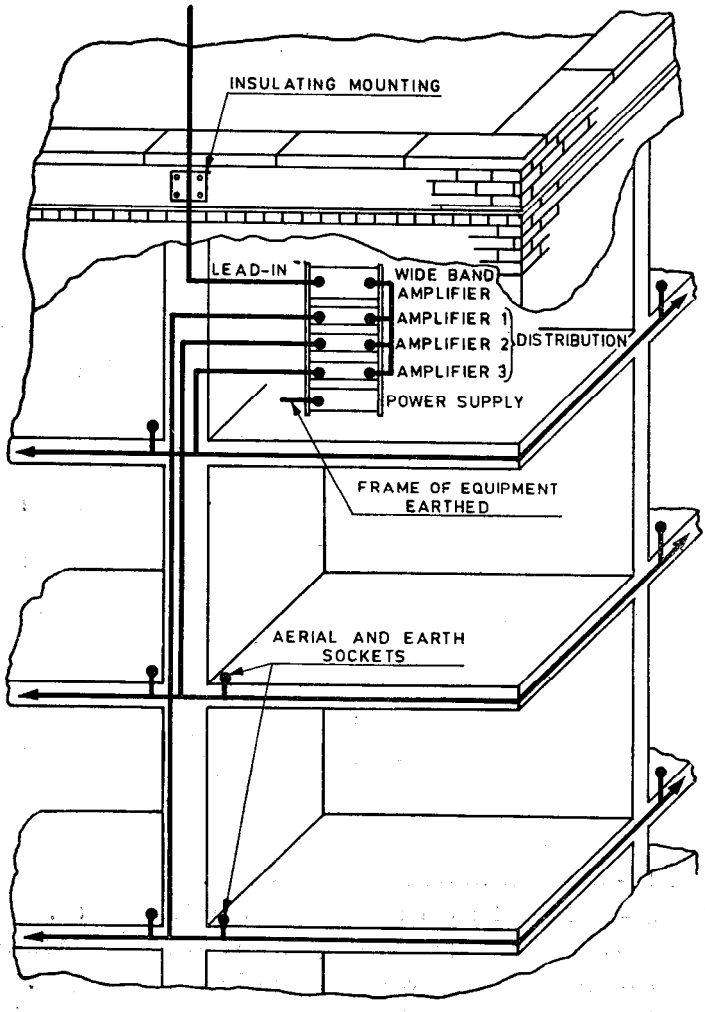
2 Transformer.

3 Screened feeder connected to transformer in each-flat; the screening of the cable to be earthed.

4 Transformer with output leads connected to aerial and earth terminals of receiver.

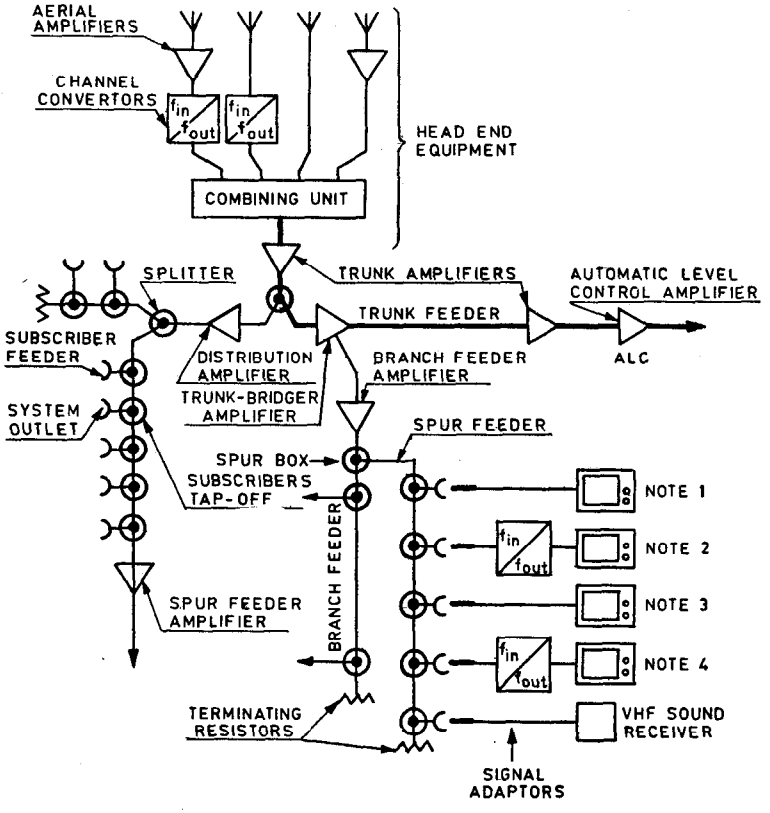
NOTE — Precautions against the effects of atmospheric electricity are dealt with in **6.6**.

FIG. 8 EXAMPLE OF LONG-, MEDIUM- AND SHORT-WAVE COMMUNITY AERIAL SYSTEM IN SMALL BLOCK OF FLATS OR TERRACE HOUSING




NOTE — Precautions against the effects of atmospheric electricity are dealt with in **6.6**.

FIG. 9 EXAMPLE OF LONG-, MEDIUM- AND SHORT-WAVE BAND COMMUNITY AERIAL SYSTEM IN LARGE BLOCK OF FLATS USING WIDE-BAND AMPLIFIER




NOTE 1 — Wired receiver connected to HF system.

NOTE 2 — Aerial receiver connected to HF system via an adaptor.

NOTE 3 — Dual-standard ( or VHF-only ) receiver connected to VHF system.

NOTE 4 — VHF-only receiver connected to VHF system via adaptor.

NOTE 5 — Not all the items shown are required in any one installation, the items required being dependent on the size, type and layout of the system.

FIG. 10 PRINCIPAL ITEMS OF EQUIPMENT EMPLOYED IN WIRED DISTRIBUTION SYSTEM

The subscriber feeder should be terminated in an outlet unit that is fitted with sockets to provide for the connection of a television or a Very High Frequency/Frequency Medulated sound receiver or both. Where both services are provided, filters should be embodied to provide isolation between VHF/FM sound and television receivers. Due care should be taken to isolate the outer and inner conductors of the cable from the outlet sockets by use of proper capacitors.

Use of proper screened cables is necessary to ensure minimum radiation from the system and adequate protection from outside interference.

**6.4.5** *System Performance* — The performance of the system should be such that when a television or sound receiver complying with the relevent Indian Standards is connected to the appropriate outlet socket on the system and tuned to the appropriate transmission the reproduction of vision and sound or sound should be acceptable. The picture should be appreciably free from noise, reflected images and other interference. Sound reproduction should be essentially free from noise and distortion.

**6.4.5.1** *Antennae* — The antenna( e ) erected shall comply with the relevent requirements of balanced or unbalanced impedance, range of input and output voltage, radiation of electromagnetic energy, frequency coverage, voltage standing wave ratio, temperature range and safety considerations.

**6.4.5.2** *Polarization* — The antenna( e ) shall be mounted in accordance with the instructions of the manufacturer and correctly oriented to ensure optimum performance.

**6.4.5.3** *Frequency coverage* — The antenna( e ) shall be suitable for covering the total band of frequencies for all the channels which are broadcast to or planned for the area in which it is erected.

**6.4.5.4** *Impedance* — The system shall generally be suitable for matching into a characteristic impedance of 75 ohms ( unbalanced ) and a voltage standing wave ratio of less than 2·5 : 1 for input circuits shall be maintained over the entire frequency range for which the system is designed. Exceptionally a system may be designed for a balanced impedance of 300 ohms or suitable value. The input circuits then shall match with the appropriate impedance.

All plugs, sockets, connectors and other components shall comply with the above requirements.

**6.5 Auxiliary Equipment** — All auxiliary equipment ( for example amplifiers, translators, frequency changers, etc ) necessary to ensure the good performance of the system shall be provided.

**6.5.1** *Translators and Channel Converters* — In high signal strength areas, where direct signal pick up of television transmissions and distribution over the community antenna system may lead to unwanted interference effects, or situations where distribution in other than the received bands is deemed necessary, translators or channel converters shall be used before the signals are distributed in the system.

**6.5.2** *Channel Conversion Frequencies* — No channel other than an unused channel that is within the recognised range of bands used by Doordarshan for VHF and UHF television broadcasting in the country shall be used for frequency conversion.

NOTE — Possible plan for channel conversion frequencies may be available from the planners for this purpose. When available, such a plan should necessarily be followed for the selection of proper frequencies.

**6.5.3** *Frequency Stability* — The frequency stability of channel converters shall be maintained to an accuracy of 1 part in $10^4$ over the entire temperature and humidity range specified for the equipment. The temperature range for equipment intended for indoor mounting shall be at least +5°C to +50°C, and the temperature range intended for outdoor mounting shall be at least −10 to 65°C.

Amplifiers used in the system shall also be subject to the same stability considerations.

**6.5.4** *Input and Output Connections* — Amplifiers, channel converters, and other components shall be so designed and constructed so that they may be connected in the cable distribution system while the appropriate impedance level is maintained.

Design of systems around unbalanced impedance of 75 ohms is recommended.

**6.5.5** *Input and Output Voltages* — As overloading, cross-modulation and other non-linear performance effects must be prevented the range of the input and output voltages of amplifiers, channel converters for which normal operation within the manufacturers specifications can be maintained must be ascertained.

**6.5.6** *Radiation of Electromagnetic Energy* — Amplifiers, channel converters and other active components shall be so designed that, when installed in a distribution system, the limits for the radiation of electromagnetic energy as specified in relevent Indian Standards are not exceeded.

**6.5.7** *Frequency Coverage* — The frequency coverage of amplifiers and other associated equipment shall be clearly specified. A voltage standing wave ratio of less than 2·5 : 1 shall be maintained for input circuits over the entire frequency range specified for the equipment.

**6.5.8** *Cables* — Standard radio-frequency cables should be used for distribution of television and/or VHF FM sound broadcast receptions to a number of receivers in the system. The following general characteristics are amongst those that determine the most suitable type of cable for use in a given situation :

a) Characteristic impedance;

b) Impedance irregularities;

c) Attenuation per unit length;

d) Type of outer conductor in coaxial cables;

e) The balance of individual pairs of multi-pair cables; and

f) Flexibility, bending radius, etc.

To secure the maximum transfer of energy and to avoid reflections that could cause distortion, the impedance of the cable used for television or VHF/FM reception should be well matched to the antenna system. The receiver input impedance shall match the feeder impedance. As far as possible long runs of feeder to individual receivers should be avoided.

It is necessary that impedance irregularities are small, otherwise standing waves and multiple images can be produced. The permissible attenuation in the cable is a matter for the designer of the system. Particular care should, however, be taken of the matching of consecutive lengths of cable both in the methods of joining and in the cable impedance tolerance limits. The screening and balance of cables is important in avoiding interference to other services and from other transmissions.

**6.5.9** *Outlet Sockets*

**6.5.9.1** *General* — At every outlet point an outlet socket shall be provided. Double outlet socket shall be provided where the system is equipped for both television and VHF/FM broadcast distribution.

**6.5.9.2** *Outlet socket voltages* — In the case of community antenna systems the outlet socket voltage at every outlet socket point measured as given below shall be within the appropriate range of the values given in Table 1.

In each band for the same input voltage the outlet socket voltages shall not vary between the channels by more than 6dB in the television and the VHF/FM bands.

Using a selective voltmeter with an input impedance of 75 ohms measure the rms value of the radio frequency voltage at the peak of the synchronising pulses on all television broadcasting services for the relevant

area, and the rms value of the radio frequency voltage on the FM sound broadcast channels for the relevant area.

**TABLE 1 OUT PUT SOCKET VOLTAGES FOR COMMUNITY SYSTEMS AND DOMESTIC SYSTEMS**

( *Clause* 6.5.9.2 )

| Sl No. | Systems | Community System | | Domestic System | |
|---|---|---|---|---|---|
| | | *Max* | *Min* | *Max* | *Min* |
| (1) | (2) | (3) | (4) | (5) | (6) |
| | | mV | mV | mV | mV |
| i) | Television Band I and III 300 ohm system | 55 | 1·5 | 55 | 1 |
| ii) | Band I and III 75 ohm system | 27 | 0·75 | 27 | 0·5 |
| iii) | Television Band I and III Fringe area 300 ohm system | 15 | 0·30 | 15 | 0·25 |
| iv) | 75 ohm system | 7·5 | 0·15 | 7·5 | 0·1 |
| v) | VHF ( FM ) 75 ohm system | 5 | 0·1 | 5 | 0·1 |
| vi) | VHF ( FM ) Fringe area 75 ohm system | 2·5 | 0·1 | 2 5 | 0·1 |

**6.5.9.3** *Mutual attenuation* — When measured as given below, the mutual attenuation between any two television outlet sockets shall exceed 33 dB and the mutual attenuation between any TV socket and FM socket that are not mounted in the same outlet box shall exceed 46 dB.

While injecting a radio frequency signal into any outlet socket at an appropriate frequency level given in Table 2, measure ( by means of selective voltmeter with an input impedance of 75 ohms ) the output of any outlet socket chosen at random to give the mutual attenuation.

**TABLE 2 TEST VOLTAGE FOR MUTUAL ATTENUATION**

| Frequency | Level | Socket |
|---|---|---|
| (1) | (2) | (3) |
| MHz | mV | |
| 65 | 2 | TV |
| 100 | 2 | FM |
| 200 | 2 | TV |

**6.6 Precautions Against Damage And Interference From Atmospheric Electricity** — Metal masts, cross-arms and booms of television and VHF/FM antenna systems should be connected to earth. In most cases, it is sufficient to ensure that the mast is earthed, relying on the clamp that secured the antenna to the mast for adequate earthing of the antenna metal work. In the case of some antenna designs the elements may not be in electrical contact with the boom to which they are secured, and no attempt should be made to earth such elements.

The antenna system should be bonded to any earthed metal work situated near the top of the structure ( for example, water tanks, pipes, etc ) using a proper earthing lamp. If no earthed metal work is available the earth connection should be made by the most direct route to the nearest earthing point. The minimum size of the conductor for this connection should be 1·5 $mm^2$. In cases where an earth terminal is not provided, the earth connection should be secured to one of the clamping bolts.

It may be possible, with some antennae, that the outer conductor of the antenna feeder cable is not connected to the metal work of the antenna. In this case the outer conductor should be separately earthed.

For protection against lightning reference should be made to IS : 2309-1969*.

**6.7 Earth Connection for Receivers** — Earth connections are provided for :

a) safety,

b) protection against atmospheric electricity, and

c) better signal reception.

For safety considerations reference may be made to IS : 616-1981†, IS : 3043-1966‡ and IS : 8240-1976§.

Sound receivers for medium and short wave bands sometimes have an earth terminal provided for the improvement of reception. When an antenna external to the receiver is used an earth is required. Provided that the earth continuity conductor of the electric supply is connected to a solid earth and interference is not introduced, the earth connection of mains operated receiver may be made by means of the earth pin of the three-pin mains plug.

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*Code of practice for the protection of buildings and allied structures against lighting ( *first revision* ).

†Safety requirements for mains operated electronic and related apparatus for household and similar general use ( *first revision* ).

‡Code of practice for earthing.

§Guide for electrical equipment for atmospheres.

If the earth continuity conductor does introduce interference, a separate 'quiet' earth should be provided. Where practicable the earth connection should be distinct from other earth connections, and should be connected by the shortest available route either to a rising metal water pipe near its point of emergence from the ground or to a buried electrode. Structural steel work of a building should not be used for obtaining an earth connection. The earth conductor should not be used for obtaining an earth connection. The earth conductor should be run as a stranded conductor of law resistance. It is essential that any metal water pipe used provides a low resistance connection with the general mass of earth and any connection to a water pipe should be made by means of a suitable clamp.

## 6.8 Equipment and Accommodation

**6.8.1** *General* — The installation initially required in a building would rarely suffice throughout the life of the building without additions or modifications, or both. Careful consideration should therefore be given at an early stage to the installation requirements particularly for community wires distributions. Provision should be made for foreseeable additions and modifications. Ease of maintenance and adequate protection against mechanical damage are of importance. Ideally it should be possible to run cables from any position in a building to any other position through concealed ducts, chases and conducts. The actual provision made will depend upon the general standard of amenities desired and the expenditure permissible. References to relevant standards shall be made while designing of ducts, chases, etc, for the accommodation of pipes and cables.

**6.8.2** *Cable Holes*

**6.8.2.1** *Outside walls* — A sleeve of non-hygroscopic material should be connected into the wall. It should slope downwards towards the outside and should be plugged with a suitable non-hardening waterproof compound to prevent the entry of rain, dust, etc.

**6.8.2.2** *Internal walls* — Surface wiring should be taken through walls in sleeves of adequate size. Sharp edges at the cable entry and exit should be avoided either by bushing or by fitting the sleeve with its ends short of the surface and rounding the plaster or other surface material. If the number of cables is so large as to render the use of a sleeve impracticable, a rectangular hole should be made and lined with wood.

**6.8.2.3** *Floors* — Similar considerations apply to floors as to internal walls. The sleeve or wooden lining should extend at least 300 mm, above floor level.

**6.8.3** *Central Equipment* — Central equipment should preferably be accommodated in a seperate room to which only authorized persons have access. The room should be dry, well ventilated and not subject to extremes of temperature. Good artificial lighting and a mains socket outlet separate from the power supply for the equipment should be provided for maintenance purposes. The floor should be constructed of or covered with non-conducting material.

**6.8.4** *Vertical Ducts* — In every multiple-floor building, vertical ducts with fire breaks, provided as necessary, are required. These should be continuous through the height of the building and their number and position should be such as to allow convenient lateral distribution on each floor. In general vertical ducts should not be more than 30 m apart as measured along the corridors. Provision for the support of cables at frequent intervals is necessary.

Where floor distribution or junction boxes are required they should be located within or adjacent to the vertical ducts.

**6.8.5** *Horizontal Ducts* — Horizontal ducts are required between the main distribution points to the various rooms and within individual rooms. If a basement is included in the building, the main horizontal duct lining the main distribution point with vertical ducts would probably be most conveniently located therein Floor distribution may be provided by underfloor ducts or conduits, floor chases, hollow detectable skirting, wall grooves with detachable covers or in hollow ceilings along corridors. Where access to positions remote from the wall may be required, full flexibility can be given by the use of under-floor duct systems.

## 7. INSTALLATION CONSIDERATIONS

**7.1 Antenna (e)** — The antenna( e ) shall be installed with following considerations :

**7.1.1** *Construction* — Each antenna and associated clamps shall be constructed in a manner consistent with good electrical and mechanical practice, and adequate steps shall be taken to prevent adverse electrolytic action.

All elements of an antenna, with the possible exception of parasatic elements, shall be directly and galvanically connected to the metal structure of the antenna. The construction of the antenna shall be such that mounting, loading, and weather conditions to which the antenna is reasonably expected to be exposed, cannot cause any part to become dislodged or permanently distorted. Steps should be taken to prevent the entrapment of water and the generation of adverse noise.

The antenna structure shall be so designed that, when it is mounted on the mast the mast will have no significant influence on the characteristics of the antenna.

It should be possible to rotate the antenna horizontally or vertically, as appropriate, to find an optimum receiving orientation. This is particularly true for VHF and TV antenna( e ).

**7.1.2** *Materials* — The installer of an antenna system should ensure that the materials used will give a reasonable operating life to the installation. Special care should be taken to avoid adverse electrolytic action between dissimilar materials. For example, copper or copper alloys should never be used in direct contact with aluminium. Protective coating of the materials should be carefully preserved. Damaged parts should be protected by a suitable coating after installaion.

**7.1.3** *Cable Connection* — The cable shall be so connected to the antenna that proper impedance matching is maintained, with due regard to balanced-to-unbalanced transformation, throughout the entire frequency range of the antenna.

The connection facilities shall be such that the outer conductor of the coaxial cable will be directly and galvanically connected to the earthing structure of the antenna by means of a conductor of cross-section at least 10 $mm^2$. The connection of the cable shall be made in a suitable connection box to protect the connection from the weather and to prevent the ingress of moisture. The enclosure shall be made of a fire retarding material. ( The effects of heat and sunlight on plastic materials should be considered if such materials are chosen for the enclosure ).

**7.1.4** *Wind Loading* — The wind loading of an antenna must be obtained for the worst mounting conditions at maximum wind velocities recorded in the area ( *see* IS : 616-1981* ).

**7.1.5** *Antenna Site* — The actual position of the antenna is of considerable importance. As far as possible all local obstructions between the antenna and transmitter should be avoided. Where reception conditions are difficult it may be advantageous to find the best position by experiment. Where practicable, antenna should be mounted clear of conductors, including structural metal work. When siting indoor antenna in the loft or attic care should be taken to position it as far as possible clear of pipes, cisterns and other metal work.

The plane of polarisation inside the building may not be the same as that of the transmitted signal and the antenna may need to be tilted accordingly.

*Safety requirements for mains operated electronic and related apparatus for household and similar use ( *first revision* ).

At sites where corrosion of the antenna structure is likely to occur as a result of salt-laden atmosphere, fumes and smoke, the antenna and its supporting structure should be provided with a suitable coating.

When an antenna is sited at an existing installation, both the strength of the installation and its suitability to carry the additional stress should be checked. The effectiveness of the existing antennae, if any, should also be checked.

**7.2 Location and Installation of Equipment and Apparatus** — Subject to any earlier specific recommendation in **6**, locations should be chosen with regard to optimum operation and where they are easily accessible for maintenance without requiring access to private premises. In all cases reference should be made to the manufacturer's instructions and standard wiring regulations.

**7.3 Assembly and Wiring** — As much assembly and wiring of the equipment and apparatus as possible should be carried out in the factory to reduce installation work to a minimum.

**7.4 Inspection and Tests** — Arrangements may be made when desired for general inspection, including operational tests, to be carried out in the presence of the purchaser's representative.

**7.5 Delivery and Storage** — To avoid damage and deterioration, equipment and apparatus should not be delivered until installation can proceed, provided that suitable storage accommodation has been made.

**7.6 Work on Site** — The work to be done on the site may consist of :

a) meeting structural requirements during building operation,

b) siting and installation of antennae and feeders,

c) internal and external cabling and wiring, and

d) fitting and connecting amplifiers, converters and combining units, etc.

**7.7 Antenna Feeder Cables** — A feeder routed externally to the antenna mast should be held by suitable clips or weather proof tape at a sufficient number of points to minimize strain on connections. A feeder taken over tilted roof should be secured by suitable clips. A loop of cable should be provided to form a water-trap together with sufficient slack for possible installation of combining units at a later date. The feeder should be taken behind the guttering and on the gutter board, or else stand-off brackets should be used. Where antenna transformers, amplifiers, etc, are used out-of doors, they should be of the weatherproof type or enclosed in fully weatherproof cover and mounted in a position that

will provide as much protection as possible. Down leads should be protected against mechanical damage. Where such downleads are exposed to high winds, they should be kept under slight tension. Unscreened cables, if any, should be mounted so that distance from walls and metallic objects is not less than ten times the spacing between the conductors.

Any down leads that are carried through the building structure by means of circuits or ducts, or are embedded in plaster should be of a screened type.

The feeder should be looped slightly away from any wood work. It should be fastened to the walls at intervals of 1 m for vertical runs and 300 mm for horizontal runs, using fixings designed to avoid damage to the cables. At the point where the feeder enters the building a water drip loop should be formed in the feeder. If it is not possible to use an air vent for the down leads in the building then entry holes should be drilled at an angle of about 45° downwards from inside the building. Internal runs of feeder runs should be as unobtrusive as possible.

Both the inner and outer conductors of the coaxial cable should be securely connected both mechanically and electrically to the plug or outlet socket. Before inserting the feeder plug to the receiver it should be ensured that no dangerous voltages exist on the aerial.

Wires and cables run on external walls of buildings should preferably be not less than 3 m above ground level. In case this is not possible then adequate protection should be provided. Rubber and PVC sheathed cables are likely to be damaged by exposure to various preservatives (for example, certain wood preservatives ).

### 7.8 Internal Cabling and Wiring

**7.8.1** *General* — Telecommunication cables should not be placed in the same ducts or conduits as power cables. Wiring should be carried out according to the standard practice.

Joints in cables should be avoided as a general rule. Suitable junction boxes should be used for connecting cables. Ends of the feeder cables should be sealed to prevent ingress of moisture.

All pipes, conduits and ducts and cables should be marked for identification.

Some plasters and cements have a corrosive effect on metals, and precautions against this may be necessary when cables or conduits are installed in damp situations.

Cables insulated with rubber, PVC or polyethylene should not be used where the cable temperature is likely to exceed 45° C without reference to the manufacturer's specifications.

**7.8.2** *Cables* — The cables should be of the standard type as recommended in **6.5.8.**

**7.8.3** *Vertical Ducts* — Cables in vertical ducts, chases, casings, etc, should be adequately supported, the provisions of wood battens, etc, will facilitate this work. Cables should be protected where they emerge.

**7.8.4** *Conduit and Metallic Ducts* — Standard practices should be followed for installing conduits. They should preferably be concealed. They should effectively be bonded and earthed.

The number and size of wires or cables drawn into any conduit or duct should be such as to permit easy drawing in the out of the cables concerned. Future expansions should be taken into consideration.

**7.8.5** *Surface Wiring* — Cables run on wall surface should be neatly laid and secured at points sufficiently close together to prevent sag. Battens should be fixed to walls where many cables are to be run or where fixing is difficult. Where cable changes direction it should not be bent to a radius less than that recommended by the cable manufacturer ( usually it is four to six times the cable diameter ). Capping can be used to advantage.

Protection by conduit or capping should be provided wherever there is a risk or damage to or interference with wiring.

Cables run on girders should be secured by metal clips. Whenever it is necessary to run the cables on tops of girders they should be run in conduit.

Cable holes as described in **6.8.2** should be used when cables have to pass through walls on floors.

**7.8.6** *Distribution and Joint Boxes*

**7.8.6.1** *Provision* — Normally it is necessary to be able to gain access to cable junctions and splitting points for testing. Therefore, such connections should be contained within a box designed to provide both protection and ready access.

**7.8.6.2** *Location* — Boxes installed outdoors should be weatherproof. Boxes likely to be vulnerable to flooding should be of a submersible type. All types of boxes should be located so as to provide reasonable access.

**7.8.6.3** *Wiring* — It is essential that pairs of wires are not divided. Where the pairs of wires are twisted within the cable the twist should be maintained up to the point of connection. Minimum amount of slack wire should be left in the bos consistent with the need to avoid fracturing the wire.

**7.9 Marking and Numbering** — All elements of the system including the antenna, conduits, ducts, etc, cables and boxes and equipment should be suitably marked for identification and extent of use.

## 8. INSPECTION AND TESTING

**8.1 Inspection of Installation** — The complete installation should be inspected by the client or an engineer authorised by him to ensure that the work of installation has been carried out satisfactorily and that the methods, materials and components used conform with the recommendations of this code. The record plans and operating instructions should be checked for accuracy and to ensure that the signal levels measured conform to those mentioned in **6.5.9** or those mentioned in this section ( **8.2** ).

**8.2 Testing of Installations** — On completion of an installation or of extensions or alterations to an installation, tests should be made to ensure that as far as possible the system meets all functional requirements and will give satisfactory service under the extreme points. In case of a community antenna system outlet socket voltages for conformity to Tables 1 and 2 as in **6.5.9** should be tested.

Typical signal levels required for satisfactory reception by receivers using external antennae shall be in accordance with relevant standards of performance ( For example IS : 4547-1978*, IS : 615-1968†, etc )

**8.2.1** *Recommended Design Details* — Notwithstanding anything contained in **6.5.9** and **8.2** it is recommended that design details given in Table 1 should as far as possible be aimed at for the antenna systems for domestic and community set-ups.

Signal levels for subscriber outlet sockets for community antenna systems for VHF, FM and TV systems should be as given in Table 1 and 2 under **6.5.9.** The community antenna systems for band I and band III should aim at following specifications.

a) Attenuation for adjacent channels — 6 dB,

b) Attenuation for in band channels — 12 dB,

c) Attenuation out of band channels — 16 dB,

d) Signal/noise ratio — better than 30 dB for minimum signal as per IS : 4547-1978*,

e) Cross modulation — better than 40 dB,

*Specification for receivers for monochrome television broadcast transmissions ( *first revision* ).

†Minimum requirements of domestic radio receivers ( *revised* ).

f) Intermodulation — better than 55 dB, and

g) Slope over a single channel — less than 0·5 dB.

NOTE — It is theoretically possible to design community TV distribution systems at HF or VHF distribution systems at audio frequencies. Recommendations for these will be incorporated at appropriate time.

Recommendations for UHF and colour TV systems are under consideration.

**8.2.2** *Protective Earth Connections* — These should be tested in accordance with standard practice.

**8.2.3** *Secondary Cells* — When they are used in the system they should be checked for satisfactory condition.

## 9. MAINTENANCE

These recommendation relate particularly to large installation and to these in which it is important to minimize the risk of failure.

**9.1 Commissioning** — Telecommunication systems generally function best when in constant use. The completion date should, therefore, be timed so that the installation can be commissioned at the earliest possible date afterwards. If this is not possible adequate arrangements should be made for maintenance.

**9.2 Regular Maintenance** — In the absence of personnel with necessary specialized knowledge an agreement should be made with the makers, suppliers or contractors for regular maintenance.

**9.3 Routine Inspection** — Routine inspection of the installations should be carried out at regular intervals particularly in regard to the security and safety of the antenna( e ).

**9.4 Log Book** — A log book giving details of all routine attention and faults should carefully be recorded so that if makers, suppliers or contractors are called in for special service they may know what services have been carried out, etc.

**9.5 Keeping of Plans** — The record of plans, diagrams and instructions, etc, should be carefully preserved and kept up-to-date.

**9.6 Masthead Equipment** — Masthead equipment needs special attention due to vulnerability to corrosion and atmospheric electricity and is usually the possible cause of unsatisfactory reception.

## 10. SEGREGATION OF CIRCUITS

**10.1 General Safety Requirements** — Cables for RF signals shall not be placed in the same ducts as power cables.

**10.2 Interference** — In many cases it may be permissible for cables of different telecommunication facilities to share ducts. Individual authorities concerned should be consulted for this type of sharing.

**10.3 Particular Safety Requirements** — Apparatus connected to telecommunication circuits associated with or energized from a low voltage or medium voltage should be isolated in such a way as to protect the telecommunication circuit from low- and medium-voltage supplies.

## 11. ABATEMENT OF ELECTRICAL INTERFERENCE

**11.1** For reception to be satisfactory, the level of electrical interference has to be low compared with that of the signal. A wide variety of domestic electrical appliance and industrial equipment may cause objectional interference, and this is best suppressed at source.

When suppression at source is not possible, some improvement may be obtained by fitting a suitable interference suppress or in the house wiring as possible with due regard to the source. Alternatively some improvement may be obtained by fitting an interference suppressor in the mains lead to the receiver.

Other possible sources include intermittent open circuit or earth faults in the electrical installation. Such defects are best guarded against by inspection and maintenance at regular intervals. Normal operation of some devices like fluorescent lamps, thyristors, etc, may give rise to salient interference.

If interference is radiated from electrical wiring associated with a source of radio noise, the severity of the interference can be reduced considerably if the wiring is enclosed in a continuous earthed metal screen. Attention should therefore be given to the bonding and earthing of existing conduit or metal sheaths of cables.

( *Continued from page* 2 )

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# INTERNATIONAL SYSTEM OF UNITS ( SI UNITS )

**Base Units**

| *Quantity* | *Unit* | *Symbol* |
|---|---|---|
| Length | metre | m |
| Mass | kilogram | kg |
| Time | second | s |
| Electric current | ampere | A |
| Thermodynamic temperature | kelvin | K |
| Luminous intensity | candela | cd |
| Amount of substance | mole | mol |

**Supplementary Units**

| *Quantity* | *Unit* | *Symbol* |
|---|---|---|
| Plane angle | radian | rad |
| Solid angle | steradian | sr |

**Derived Units**

| *Quantity* | *Unit* | *Symbol* | *Definition* |
|---|---|---|---|
| Force | newton | N | 1 N = 1 kg.m/s$^2$ |
| Energy | joule | J | 1 J = 1N.m |
| Power | watt | W | 1 W = 1 J/s |
| Flux | weber | Wb | 1 Wb = 1 V.s |
| Flux density | tesla | T | 1 T = 1 Wb/m$^2$ |
| Frequency | hertz | Hz | 1 Hz = 1 c/s (s$^{-1}$) |
| Electric conductance | siemens | S | 1 S = 1 A/V |
| Electromotive force | volt | V | 1 V = 1 W/A |
| Pressure, stress | pascal | Pa | 1 Pa = 1 N/m$^2$ |